Commercially Available Products Used for Parenteral Precision Ketogenic Therapy

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Abstract

Many patients in the intensive care unit (ICU) require parenteral nutrition for a variety of issues. Patients with seizures receiving Precision Ketogenic Therapy (PKT) based on a low carbohydrate dietary intake may consume it orally or via an enterally feeding tube. Patients admitted to the ICU on PKT need to continue PKT and other patients may need to begin PKT for new seizures. We created a nutrient composition database of parenteral nutrition food products. There are no parenteral products designed for a ketogenic diet. The macronutrient composition of pure amino acid solutions, pure fat emulsions, and pure dextrose solutions were included in the database and can be used in PKT recipes. Intravenous medications based on dextrose or a lipid emulsion are frequently used in the ICU. The parenteral PKT database can be used to illustrate the effect of using these medications on PKT and the need to include the medication solution macronutrient in the calculation of the PKT recipes for that specific patient. Amino acid solutions or fat emulsions of different brands have different compositions of individual nutrients. Extending our database to individual nutrients will facilitate testing published suggestions that individual amino acids and fatty acids affect seizure control differently.

Introduction

When the gastrointestinal (GI) tract is unavailable for food including Precision Ketogenic Therapy (PKT), people must receive PKT intravenously. PKT prescriptions are based on the PKT ratio which is the ratio of fat (grams) to protein (grams) plus carbohydrate (grams). Thus, an intravenous source of fat, protein and carbohydrate are required to administer parenteral PKT. Patients in the intensive care unit frequently receive IV medications compounded in solutions containing nutrients. For over a century, medical professionals have used total fat, total protein, and total carbohydrate to determine the PKT ratio. However, during this time, many peer reviewed scientific papers have clearly shown that different fatty acids, different amino acids, and different saccharides have very different effects on normal metabolism and on metabolism during disease. Since fat is found in the highest concentration in PKT, the fatty acid profile of the PKT dietary intake should be carefully defined and monitored to facilitate evaluation of the effect of different fatty acid profiles on a person's progress on PKT.

Purpose

The purpose of this project is to address the following questions:

- Do hospitals have to stock special parenteral solutions to provide parenteral PKT?
- What is the effect on the PKT ratio when IV medications compounded in dextrose or lipid emulsions are administered?
- How do the fatty acid profiles of lipid emulsions available for PKT differ?

Data

PKT Ratio Without and With Medications

Solution Administered	PKT Ratio
PKT	2.50
PKT + Propofol	2.89
PKT + Nitroglycerin	2.25
PKT + Clindamycin	2.21
PKT + Norepinephrine	2.06
PKT + Dopamine	2.00
PKT + Lidocaine	1.93
PKT + Vancomycin	1.90

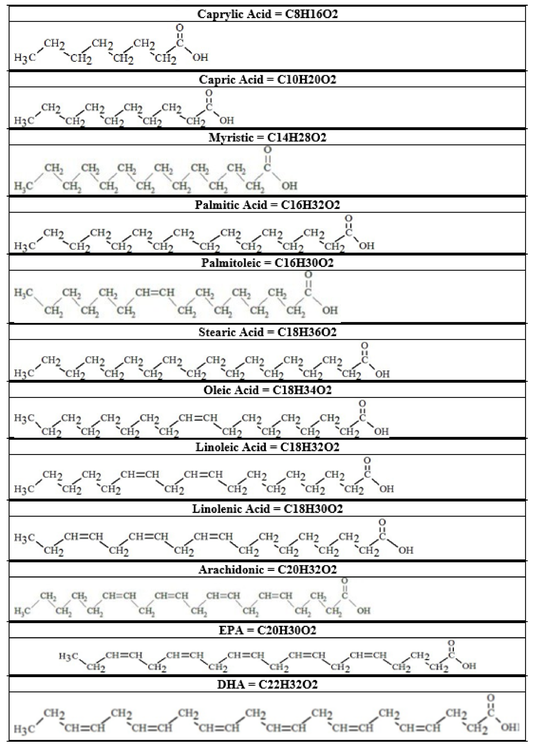
Fatty Acid Profiles of Lipid Emulsions

Fatty Acids (#Carbons: #Double Bonds)	Nutrilipid	Intralipid	SMOF	Omegaven
Oleic (18:1)	17%-30%	19%-30%	23%-35%	4%-11%
Linoleic (18:2)	48%-58%	44%-62%	14%-25%	1.50%
Caprylic (8:0)			13%-24%	
Capric (10:0)			5%-15%	
Stearic 18:0	2.5%-5.0%	1.4%-5.5%	1.5%-4%	
Palmitic (16:0)	9%-13%	7%-14%	7%-12%	4%-12%
Linolenic (18:3)	4%-11%	4%-11%	1.5%-3.5%	1.10%
Eicosapentaenoic (20:5)			1.5%-3.5%	13%-26%
Docosahexaenoic (22:6)			1.5%-3.5%	14%-27%
Palmitoleic (16:1)				4%-10%
Myristic (14:0)				2%-7%
Arachidonic (20:4)				0.2%-2%

Parenteral PKT Compounded Using Frequently Used Parenteral Solutions

Protein Source	Travasol 10%
Carbohydrate Source	10% Dextrose Injection USP
Lipid Source	Intralipid 10%
PKT Ratio	2.5

Fatty Acid Structures



Discussion/Conclusion

- When the GI tract is unavailable, people can receive PKT intravenously using the parenteral nutrition solutions usually available in most hospital pharmacies.
- Administering IV medications containing dextrose or lipid emulsion alters the PKT ratio, and thus PKT solutions must be changed each time such medications are administered to accommodate the added nutrients.
- Of the four lipid emulsions investigated, Intralipid and Nutrilipid had similar fatty acid profiles. However, the fatty acid profiles of SMOF and Omegaven were different from that of Intralipid and Nutrilipid and different from each other. Importantly, the fatty acids that differed in concentrations are fatty acids that have been reported to be important to control during diseases treated with PKT.